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Abstract

The process of developing the Air Force Technical Applications Center (AFTAC) Knowledge Base (KB) includes integration of high-quality Integrated Research Products (IRPs) that support activities for monitoring nuclear explosions consistent with United States treaty and testing moratoria monitoring missions. The validation, verification, and management of the IRPs is critical to successful scientific integration, and hence, will enable operationally useful deliveries to be made to AFTAC. As an IRP passes through the steps necessary to become part of a KB at AFTAC, domain experts (including technical KB Working Groups [WGs] that comprise National Nuclear Security Administration [NNSA], Department of Energy (DOE) laboratory staff, and the customer [AFTAC]) provide coordination and validation, where validation is the determination of relevance and scientific merit. Verification is the check for completeness and correctness, and will be performed by both the KB Integrator and the Product Integrator at the Science Integrator laboratory with support from the product Contributors, providing two levels of testing to assure content integrity and performance. The IRPs will be systematically tracked through the development, integration, and evaluation portions of their life cycle. The integration process, significantly streamlined and with its execution substantially shifted to AFTAC due to maturation since its initial implementation, is presented in this report.

Acknowledgements

This document summarizes the integration process developed by many researchers with diverse backgrounds from seismology and computer science to geographic information systems and configuration management. The integration organizations represented are four DOE National Laboratories: Sandia (SNL), Los Alamos (LANL), Lawrence Livermore (LLNL), and Pacific Northwest (PNNL). These organizations are part of the Ground-based Nuclear Explosion Monitoring Research & Engineering (GNEMRE) Program (https://www.nemre.nnsa.doe.gov/) of the National Nuclear Security Administration's (NNSA) Office of Nonproliferation Research and Development (NA-22). The wide array of disciplines represented increases the probability of success for use of these processes and procedures. The core of the integration process was transitioned from SNL to AFTAC effective November 2007.

Special appreciation goes to the GNEMRE participants who developed the previous versions of this document and who participated in numerous process definition meetings and reviews, providing experiences, insight, and suggestions fundamental to building a meaningful process to serve the collective integration needs.

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1. Introduction

The National Nuclear Security Administration (NNSA) Ground-Based Nuclear Explosion Monitoring Research & Engineering (GNEMRE) program provides research and development in support of United States' nuclear explosion monitoring missions. Specifically, the GNEMRE program provides products that will be utilized by the Air Force Technical Applications Center (AFTAC) in operation of the United States National Data Center (USNDC), consistent with the responsibilities set forth in the Memorandum of Understanding enacted in May 2001 and updated in August 2005 (see Appendix). To serve this role, the GNEMRE program tracks and integrates products as they move from the research level to operations and ensures that these products are reliable, technically correct, and operationally useful. In doing this, the GNEMRE program draws research results from NNSA-sponsored research as well as relevant research sponsored by others.

The process that ultimately results in making new capability available to AFTAC consists of 3 parts:

- Development: Operationally useful technical products (scientific data and the tools to manipulate them) that support the United States' nuclear explosion monitoring mission at AFTAC, are developed by GNEMRE researchers and others and put into operationally useful forms called Integrated Research Products (IRPs).
- Integration: Technical products are integrated into a comprehensive and cohesive package (Knowledge Base) that can be readily utilized by AFTAC. This integration used to happen at Sandia National Laboratories (SNL), requiring a subsequent delivery step, but as of November 2007 all integration is done at AFTAC. This shift of the bulk of the integration process to AFTAC is a result of the maturation of the process; however an additional benefit of the shift is that there are fewer steps overall.
- Evaluation: AFTAC personnel evaluate the content of the KB on a product-by-product basis for operational use.

The practical implementation of the development, integration, and evaluation of products occurs through the process of updating the Knowledge Base (KB) in use at AFTAC. The KB is composed of a set of IRPs, which includes data sets, software tools, and technical reports. In addition, each IRP also includes critical supporting information (metadata) describing how it was prepared and how it is intended to be used.

The process whereby KB content is developed, integrated, and evaluated into the KB at AFTAC is described in this document.

2. What's New

In March and September 2007, two significant changes to the KB Integration Process were approved by the KB Integration Board (IB):

- Integration of the KB will be done at AFTAC by a KB Integration Team consisting of SNL and AFTAC personnel. In the past most of the integration was done at SNL, and all the integration work was done by SNL personnel.
- The KB content will be steadily updated as products are deemed ready, instead of periodically replacing the entire KB.

This updated version of the KB Integration Process document reflects these key changes.

3. Scope and Audience

This document summarizes the KB integration process for the results of research, regardless of sponsor. It is intended that any interested party will find this document helpful in providing transparency to the integration process and as an aid to effective participation in the process.

For those responsible for the hands-on KB integration, this document gives a general description of the process and procedures thereof. In particular, those individuals playing the role of KB Integrator and those who interact directly with the KB Integrator should find this document useful in describing the integration process from beginning to end.

The Contributor's role is more fully addressed in the companion document, The National Nuclear Security Administration Knowledge Base Contributor's Guide (Carr, 2003). Similarly, the Product Integrator's role is described in more detail in another companion document, The National Nuclear Security Administration Knowledge Base Product Integrator's Guide (Carr, 2007).

From a managerial perspective, this document seeks to provide an overview of the KB integration process to assist in effective tracking and management of research and development activities. Participants include Contributors at the national laboratories, universities and private organizations, Science Integrators (LANL, LLNL, PNNL, and SNL), Product Integrators, KB Integrators, process entities such as the KB WGs and the KB IB, and the Operational Users (see Section 4.0). Contractual research obligations and their relationship to data products are not addressed here. However, for the verification and validation of the integrated products, as well as the operational use of the KB, a mapping from a contract to a data product can be found in the metadata provided with each IRP. Traceability of information to its source is an important attribute of both the integration process and the KB as an end product.

4. Knowledge Base Composition

The organizational structure of the KB is shown as a simplified schematic in Figure 1. The fundamental building blocks of the KB are referred to as research products. The term research product in this document refers to data sets, associated software research tools, and technical reports. Typically, one or more similar or related research products are grouped together for operational usefulness as an IRP. Metadata accompany each IRP and describe the content, source, quality, and status of the included research products. A collection of IRPs makes up the KB.

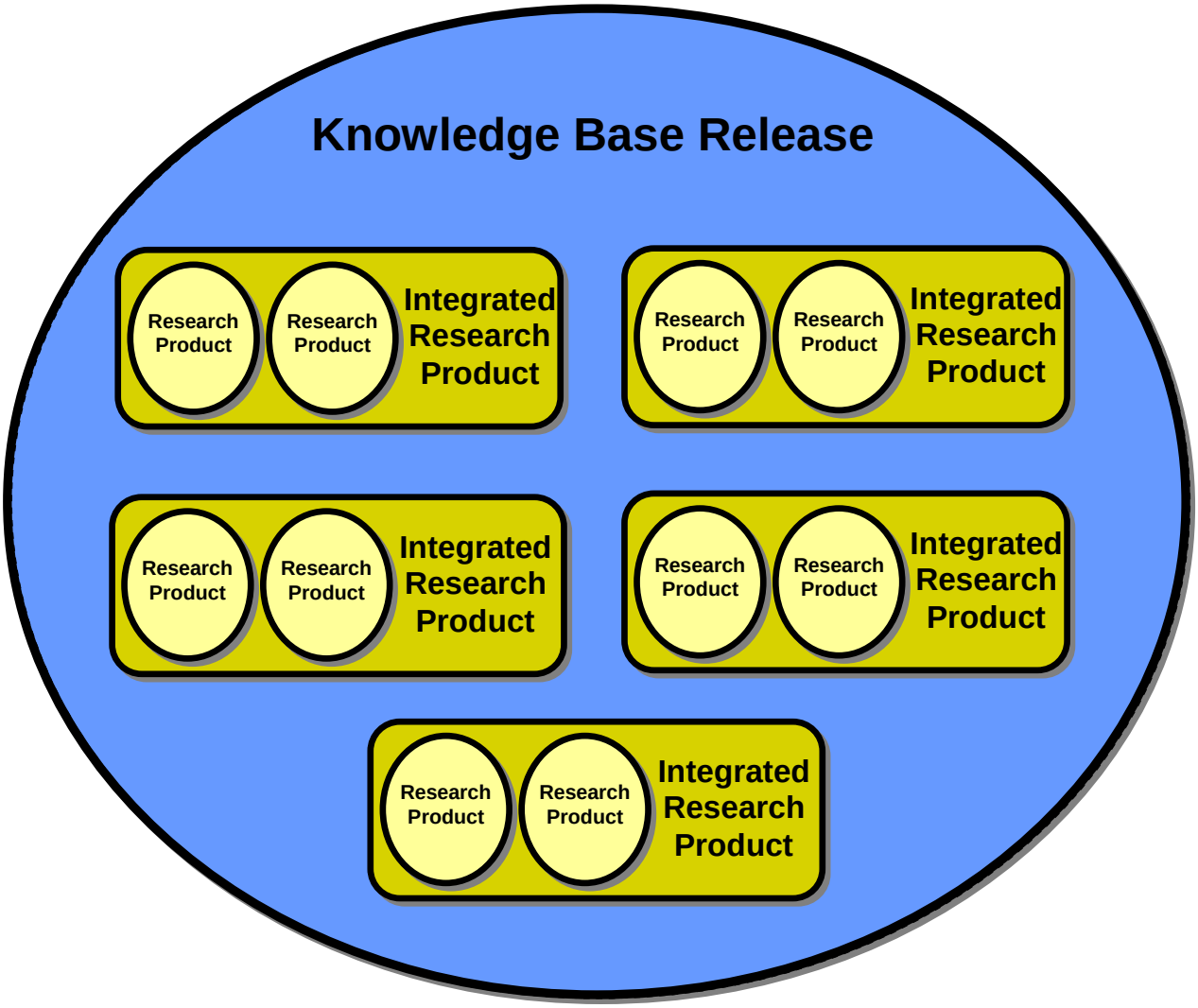

Figure 1—Knowledge Base components

The data sets are the most important part of the KB, and much of the GNEMRE effort is devoted to developing them. The data sets provide the means to improve monitoring capability for selected regions and/or scenarios. A data set is a collection of one or more objects, usually all of the same kind. These objects span a wide variety of types, e.g., seismic event catalogs, travel-time corrections surfaces, GIS contextual information, magnitude formulas, etc. Each data set is carefully quality checked and fully documented.

While it is the content provided by the data sets that ultimately determines the value of the KB for nuclear explosion monitoring, in most cases that value cannot be realized without the KB software tools. This software is usually designed to provide a method of displaying or applying the information within a data set. Such software permits users to examine, validate, and apply the data sets to solving problems. KB software tools are considered separate research products, each with its own documentation.

The KB technical reports span a variety of topics related to explosion monitoring. Some discuss general use algorithms, while others recommend monitoring practices for specific regions. By their nature, reports require much less handling than data sets or software tools, but their development still follows the process described in this document.

As will be described in the following section, research products (data sets, software tools, technical reports) are packaged into IRPs that can be integrated into the KB through the coordination and integration efforts of the Product Integrators and the KB Integration Team, as supervised by the KB IB.

5. Knowledge Base Integration and Evaluation Process

This document delineates the integration process and procedures we have developed to manage IRPs as they migrate from the applied development world toward an AFTAC KB used by AFTAC in their USNDC operations. The integration process applies to both NNSA and non-NNSA funded contributions. The process is designed to guide the integration of diverse research contributions through a well-defined set of procedures.

To successfully monitor explosive nuclear testing, access to large quantities of detailed technical and contextual information is needed. The smaller, regional distance events expected in the emerging monitoring environment require a significant increase in the amount, type, and detail of information provided to both automated systems and human analysts. The KB is intended to provide this mass of information in a form that is ordered, consistent, easily accessed, well documented, reproducible, accurate, and relevant. Verification will ensure that it is complete, in the correct form, and properly documented. Validation will provide assurance that the integrated research products are appropriate (i.e., have scientific merit, accuracy, and relevance) for the USNDC mission.

Integration of any kind requires planning. However, even when integration is carefully planned, there can be unforeseen difficulties. The interdependencies among contributions to the KB offer a challenge. Facilitating the smooth integration of the research work of many organizations into a consistent KB, while maintaining technical substance in the contributions, is the primary objective of this document. Integration of specific IRPs into a KB does not guarantee acceptance by the USNDC, which exercises its own review process after receipt of a new or updated IRP. However, significant coordination with the USNDC is an integral part of the NNSA integration process.

The integration and evaluation process, shown in Figure 2, illustrates an overview of the flow of potential KB datasets and software tools as they migrate step-by-step into the KB that is available to the Operational Users. Evaluation by the Operational Users is ongoing at all steps of the integration process.

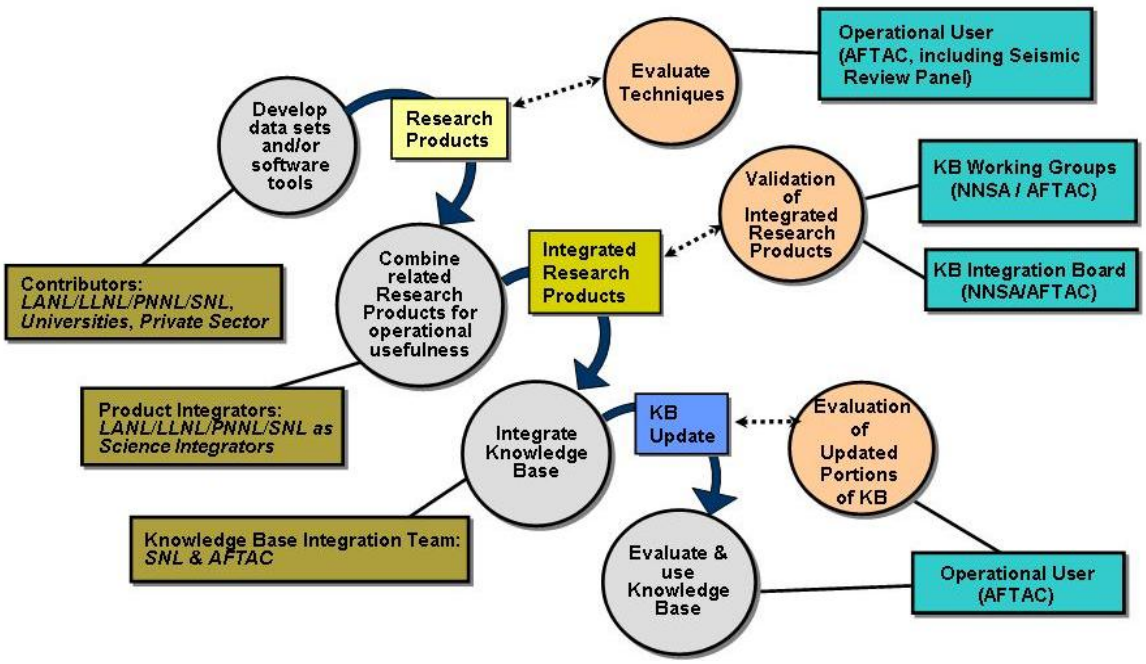

Figure 2—Knowledge Base integration and evaluation process

In Figure 2, the integration series of elements (grey circles), beginning with "Develop data sets and/or software tools," depicts how research products are packaged into IRPs, and then integrated into an updated KB. The boxes to the left of this integration series are the specific players who conduct each of the integration steps. The circular elements to the right of the integration series represent the technical evaluation and subsequent validation that occurs at each step in the process. The boxes to the far right are the specific players that conduct these evaluations. Key characteristics of this process are that products (i.e., research products, IRPs, KB) are verified and validated at each step in the process, and that the Operational User (AFTAC) is involved in verification and validation throughout the process. This type of AFTAC involvement is important because the end user is critical in the early-on determination of relevancy and usefulness of any given research product or IRP, as well as evaluation of technical accuracy. With the changes in 2007, the level of AFTAC involvement has markedly increased: now AFTAC personnel are part of the KB Integration Team (along with SNL personnel) and all of the integration is done at AFTAC.

The technical KB WGs remain critical to the integration process and provide not only guidance with initial IRP packaging, but also technical expertise throughout the process. The KB WGs comprise NNSA and DOE Product Integrators and representatives from AFTAC. For a given KB Release, these KB WGs serve the primary functions of verification, validation, and coordination associated with a specific IRP. In the initial phase, the KB WGs interact with researchers to provide technical guidance and feedback for development of the research products that form the basis for IRPs. Later, in the integration phase, the KB WGs work with the Product Integrators and KB Integration Team to verify that the IRPs are technically accurate, functionally validated, cohesive, and complete.

Following review of the individual new/updated IRPs by the KB WGs, the new/updated IRPs are

proposed to the KB IB for review and approval. Once approved, the new/updated IRPs are integrated into the KB, which is then made available to the end user—AFTAC—for evaluation, comment, acceptance in whole or part, and finally, implementation. Specific steps along the integration process are described below.

5.1. Process Description

The process through which research products and IRPs move into the KB can be divided into three distinct parts: IRP Development, IRP Integration, and IRP Evaluation. These parts are shown in Figure 3, broken down into tracking steps.

	#	Step
IRP DEVELOPMENT	1	Product Integrator proposes IRP to WG and notifies the KB Integrator to assign P# and enter information into the Product Tracking Tool.
	2	WG (through Lab Leaders) proposes IRP to IB.
	3	IB approves development of IRP, documents this approval in minutes and sends notification to WG.
	4	KB Integrator assigns an IRP Validator to the IRP and notifies the Product Integrator and updates the Product Tracking Tool.
	5	Product Integrator creates action plan (development schedule) for the IRP; will be different for every product.
	6	WG (through Lab Leaders) informs IB and KB Integrator that the IRP is mature and ready to be integrated into the KB.
IRP INTEGRATION	7	KB Integrator sends Product Integrator the Integration/Info form for product-specific integration requirements.
	8	IRP Editor sends IRP template or previous version of IRP document to Product Integrator.
	9	Product Integrator sends the completed Integration/Info form to KB integrator.
	10	Product Integrator/KB Coordinator sends IRP to KB Integrator.
	11	IRP Validator sends email to KB Integrator that IRP is ready for integration and KB Integrator updates the Product Tracking Tool.
	12	KB Integrator completes integration of the IRP (merging of database tables, file updates) and upates the Product Tracking Tool.
	13	Product Integrator sends final IRP documentation to IRP Editor.
	14	IRP Editor edits IRP document and sends both the PDF and Frame/Word versions to KB Integrator.
	15	(If necessary) IRP Editor goes to AFTAC to edit AFTAC-only IRP documents and gives the PDF and Frame/Word versions to the KB Integrator.
	16	KB Integrator sends PDF copy of the IRP document to IB.
	17	KB Integrator places IRP document in directory structure and updates the Product Tracking Tool.
	18	KB Integrator updates the KB Navigator nodes and sends email to the IRP Validator to test product through the KB Navigator.
	19	IRP Validator sends email to KB Integrator that the IRP was integrated successfully.
IRP EVALUATION	20	AFTAC completes detailed evaluation of IRP and sends report to IB.
	21	IB meets to review final IRP documents and the KB Summary document and verify completeness of updated KB.
	22	KB Integrator and Product Integrator begin demo of updated portions of KB to AFTAC users.
	23	KB Integrator moves IRP entry to the stable product view in the Product Tracking Tool.
	24	IB meets to review KB Release Summary after the delivery of the catalog IRP that occurs on a roughly six month schedule. All IRPs that have been integrated into the six month period will be added to the KB Release Summary. The KB Integrator writes the KB Release Summary.

Figure 3—IRP development, integration, and evaluation tracking steps

In the IRP Development part of the process, the IRP is proposed to the KB IB and developed in consultation with the appropriate KB WG and specific researchers at AFTAC. The IRP Integration process starts with the KB WG declaring an IRP ready for integration into the KB and getting the IRP and its required documentation to the KB Integration Team. The KB Integration Team then follows specific procedures to integrate the IRP into the KB. In the final part of the process, IRP Evaluation, the IRP is evaluated in detail by AFTAC, and the KB IB approves the documentation.

The steps below provide a brief overview of the process. The corresponding detailed process steps from Figure 3 are shown after each section heading.

5.1.1. IRP Development - Research Product Content Development and IRP Initiation (Step 1)

Contributors perform monitoring research and development and create research products that have potential operational use at AFTAC. A Product Integrator receives one or more research products from one or more Contributors. These activities occur prior to IRP tracking, and therefore are not shown in Figure 2. However, once one or more related research products are received by the Product Integrator, the Product Integrator can propose the creation of an IRP, which groups/packages research products for operational usefulness, to the appropriate KB WG, and notifies the KB Integration Team to assign a product number so that progress can be tracked (Step 1).

5.1.2. IRP Development - Integrated Research Product Proposal and Approval (Steps 2-4)

The KB WG proposes to the KB IB that the IRP be included in the KB. The objective of the KB IB is to ensure that AFTAC's needs are addressed, and as such, they may reject an IRP if it does not address an AFTAC need. The KB Integration Team will consult with AFTAC to find the right person from AFTAC to be the IRP Validator. The IRP Validator will be an important contact for the Product Integrator as the IRP is developed.

5.1.3. IRP Development - Integrated Research Product Development and Assembly (Steps 5-6)

Once an IRP has been approved, the Product Integrator executes a plan to build it. The plan is documented by the responsible Product Integrator in an action plan that defines the development schedule for the IRP. An action plan is a document generated by the responsible Product Integrator that describes the steps being done on an integrated research product to get it to a mature state. Important parts of the action plan are the dates of past and future interim deliveries. The action plan can be updated at anytime, particularly when there is feedback from AFTAC after an interim delivery. While the format of the plan is not constrained or prescribed, at a minimum the action plan must include dates of the interim deliveries of the IRP to AFTAC. The plan should be updated regularly with feedback from the IRP Validator after these interim deliveries.

The Product Integrator may solicit data sets or algorithms from the original Contributor as part of

the plan or may refer the Contributor to the NNSA Knowledge Base Contributor's Guide (Carr, 2003), which guides the Contributor through the process of preparing data sets for transfer. For certain types of data sets, specific formats are required (see Carr, 2007), and often the formatting is done by the Product Integrator after receiving the research product from a Contributor.

As part of product assembly, the Product Integrator will reformat data or recode algorithms to be compatible with AFTAC software. Extensive testing of the finished product follows to ensure proper operational use. The Product Integrator creates IRP documentation, which includes any metadata, product installation procedures, and tests following NNSA templates (see Carr, 2007).

5.1.4. IRP Integration – Acceptance Testing for Mature Integrated Research Products (Steps 7-11)

IRPs are tested by the Product Integrator prior to delivery to the KB Integration Team using procedures and tools agreed to by the KB Working Groups to ensure scientific validity. These tests may be performed at the Product Integrator's site or in the development area at AFTAC as appropriate for the type of IRP and as agreed between the Product Integrator and IRP Validator. If the Product Integrator validation test was not done at AFTAC, the IRP Validator may repeat the validation test in the AFTAC environment. When IRP validation is successful, the IRP Validator will send email to the KB Integration Team that the IRP is ready for integration into the KB.

5.1.5. IRP Integration – Documentation (Step 13-17)

The IRP Editor sends the Product Integrator either a classified IRP document template or, if the IRP is being updated, the previous version of the IRP document. The Product Integrator will need to complete the IRP documentation, and then have a derivative classifier at the Product Integrator's lab review the document for classification. The IRP template has a cover page that includes all the necessary classifier markings. When the IRP document is finished, the Product Integrator sends it back to the IRP Editor. The IRP Editor does final editing and creates a PDF document. If the document contains information that cannot leave AFTAC, the IRP Editor goes to AFTAC to do the final editing of the document at AFTAC. The IRP Editor sends the final IRP document to the KB Integration Team, who forwards it on to the KB IB.

5.1.6. IRP Integration – Integrated Research Product Integration and Validation (Steps 12, 18-19)

The Product Integrator sends the IRP to the KB Integration Team for integration. The IRP Validator makes sure that all the files and database tables that make up the IRP have been delivered, and does testing to make sure it works as expected. The KB Integration Team integrates the IRP into the KB and updates the KB Navigator layout. (The KB Navigator is a custom-developed software tool that presents the KB content to AFTAC users in a simple "point-and-click" style). Then the IRP Validator tests the IRP through the KB Navigator, to make sure the content (both new/updated as well as carryover) still works as expected after integration.

5.1.7. IRP Evaluation – AFTAC Detailed Evaluation (Step 20)

AFTAC personnel critically evaluate the IRP. When possible, the IRP is evaluated using AFTAC data to test effectiveness for various monitoring tasks. Performance is the most important criterion, but organization, ease of use, and completeness of metadata are factors. Detailed feedback for the IRP is provided to the Product Integrator through a written report to the KB IB coupled with discussions at KB Working Group meetings. The Product Integrator then guides product updates and new product development based on this feedback. Following evaluation, AFTAC chooses suitable IRPs for implementation in their USNDC processing pipeline.

5.1.8. IRP Evaluation – KB Integration Board Review (Step 21)

The KB IB reviews the AFTAC evaluation document and the IRP document. The major task of the KB IB is to verify the completeness of the updated KB. On a regularly scheduled basis, a KB Summary document will be written by the KB Integration Team. This document will summarize all the IRPs in the AFTAC KB, clearly identifying the new/updated IRPs that have been integrated in the KB since the last KB Summary document was compiled. It will also include a delivery schedule for products in development.

5.1.9. IRP Evaluation – Demonstration and Move to Operational Mode (Steps 22-24)

The evaluated and approved IRP is demonstrated to AFTAC by the Product Integrator who travels to AFTAC to discuss use of the product and provide hands-on training. Successful demonstration is the indication of readiness to cease development of an IRP since it is ready for operational use. At this point, the IRP is called “stable” and is removed from active product tracking as it is now maintained in the operational KB.

5.2. Integration Process Participants - Roles & Responsibilities

The KB integration process is executed by a variety of people acting in a variety of roles. Both NNSA-funded and non-NNSA-funded Contributors begin the integration process with assignment of a NNSA lab contact, or Product Integrator, who will perform process coordination functions and acts as the interface between the Contributor and the rest of the Knowledge Base participants (see Carr, 2007). An NNSA Product Integrator is assigned when contracts are awarded and assignments are shown on the GNEMRE Coordination web site (https://www.nemre.nnsa.doe.gov/cgi-bin/prod/coord/index.cgi) on the list of contracts. The flow of information from Contributors to Science Integrators to the KB Integration Team corresponds to integration of products shown in Figures 1 and 2. That is, Contributors develop products at the level of the research products depicted in Figure 1. Contributors then provide these research products to a Product Integrator (at a Science Integrator laboratory), who combines several into an IRP. The Product Integrator provides an IRP to the KB Integration Team who integrates the IRP into the KB.

To help determine what kinds of research products are needed, the Operational User provides the general requirements definitions that apply to specific KB Working Groups. The KB Working Groups then conduct requirements analysis and recommend different kinds of products that will

address the Operational User defined requirements. In addition, the KB Working Groups provide coordination during IRP development, implementation of specific approaches to address the requirements, technical validation of IRPs, and technical issue resolution.

The list of roles below provides definitions of the responsibilities for each of the integration process participants, some of whom are represented in Figure 2.

5.2.1. Contributor(s)

An individual or group of individuals creating research products for delivery to a Product Integrator. A Contributor may be from a NNSA or DOE laboratory, a university, or the private sector.

5.2.2. IRP Editor

An individual or group of individuals who edit an IRP document from a Product Integrator.

The IRP Editor:

- has a comprehensive understanding of the KB concept,
- acts as the single point of contact and final editor for a given IRP document,
- works with the KB Integration Team to identify the Product Integrators that have IRPs ready to be integrated into the KB, and
- resolves KB Working Group and KB IB comments on draft IRP documents prior to delivery to the KB Integration Team.

5.2.3. IRP Validator

An individual from AFTAC who is assigned as the AFTAC evaluator for an IRP. They work with a Product Integrator to get the IRP into a mature state so it can be integrated into the KB.

The IRP Validator:

- is a subject matter expert for the monitoring task that the IRP is proposed to address,
- has a comprehensive understanding of the KB concept,
- acts as the single AFTAC point of contact and final validator for a given IRP
- provides feedback to the Product Integrator as an IRP being developed,
- works with the KB Integration Team to verify that an IRP has been successfully delivered, and
- works with the KB Integration Team to verify that an IRP has been successfully integrated.

5.2.4. KB Integration Board

The KB IB is permanently composed of a program leader and deputy from each contributing laboratory, the NNSA sponsor, and a technical representative from the KB Operational User. The IB approves development of IRPs being proposed for inclusion in the KB. The program leaders may choose other technical representatives to aid in evaluating the IRPs. This group will be as small as possible in order to remain focused and functional. The IB tracks the development of each IRP by the use of Action Plans and the Product Tracking Tool. After an IRP has been successfully integrated into the AFTAC KB and evaluated by AFTAC, the IB

reviews the IRP document and verifies the completeness of the updated KB.

The KB IB:

- approves potential IRPs for development,
- reviews the contents of an IRP,
- is advised by the IRP Action Plan and Product Tracking Tool,
- is informed by the IRP documents,
- provides assessment of updated KB readiness to AFTAC,
- ensures that the next KB Summary date is always scheduled and known to the Product Integrators.

The KB IB acts as a reviewer and interfaces with the Science Integrators and the KB Integration Team.

5.2.5. KB Integration Team

Individuals who merge integrated research products into the AFTAC KB. The KB Integration Team has members from both SNL and AFTAC.

The KB Integration Team:

- reviews the Files and Installation Testing Procedure sections from the IRP document,
- receives the IRP deliveries,
- verifies that the IRP was successfully transferred to the KB Integration Team by comparing what was received to the Files section of the IRP document,
- validates the stand-alone IRP by following the Installation Testing Procedures from the IRP document,
- integrates the IRP into the KB,
- re-validates the IRPs once they have been integrated into the KB using the same Installation Testing Procedures as before,
- oversees the IRP Editor,
- organizes review of KB updates by the IB,
- prepares the KB Summary document for review by the IB, and
- tests the KB as a system using the KB Navigator.

The KB Integration Team interfaces with the Product Integrators, the IRP Editors, the KB IB, and the Operational User.

5.2.6. KB Summary Document Editor

An individual or group of individuals who edit the KB Summary document.

The KB Summary Document Editor:

- has a comprehensive understanding of the KB concept,
- acts as the final editor for the KB Summary document
- resolves KB IB comments on draft KB Summary documents prior to document finalization.

5.2.7. KB Working Group

A group of topically-related technical experts (i.e., domain experts), developers, and users, who provide coordination for research products and IRPs. The KB WGs provide integration,

and technical validation prior to KB IB review. KB WGs are largely comprised of Product Integrators from the Science Integrator laboratories.

The KB WGs:

- recommend initial IRPs to the KB IB for development and integration into the KB
- identify outstanding technical issues, assign some level of priority to those issues, and develop strategies and technically sound methodologies for addressing these issues
- provide guidance on IRP definition through requirements analysis
- validate the use of a specific methodologies for developing research products and IRPs
- assist in the requirements definition for research products
- validate site-specific models and the data created through implementation of those models
- assess and report on the quality of any empirical data to be delivered or used
- assess and report on the operational usefulness of tools and data sets, which may include some validation of analytical and content creation software products
- provide technical feedback and recommendations to researchers
- conduct technical validation of completed IRPs,
- provide advice to the KB IB regarding readiness of IRPs, and
- assist with metadata preparation, including lineage-to-source information.

Members of the KB WGs can act as Contributors, Product Integrators, and domain expert reviewers to provide evaluation and assessment of a particular product. Members of the KB WGs interface with other Product Integrators, the KB Integration Team, the IRP Editor, and the KB IB.

5.2.8. Operational User

Customers/users that employ the KB in an operational setting. The Operational User to whom the KB is delivered is AFTAC. As the KB user, AFTAC brings considerable expertise to the interpretation process; for example, operational experience and the expert advice of the AFTAC Seismic Review Panel.

Specifically, the Operational User:

- provides general requirements for KB development and use
- participates in the KB WG activities
- participates in KB IB assessments and determinations, and
- independently assesses IRPs and provides comments and recommendations to the KB WGs

5.2.9. Product Integrator

A scientist at a Science Integrator laboratory assigned by the NNSA to be responsible for coordinating with specific research and development contractors, particularly those not funded by NNSA. The Product Integrator's responsibility is to determine whether the contractor's results and products could or should be considered for incorporation into the KB and to facilitate transfer of the information through the KB WG to the KB Integration Team.

The Product Integrator:

- has a good overall understanding of the portion of the KB related to their IRP,
- works within the scope of the contract as negotiated by the Contributor and the funding agency,
- obtains published reports from the contract and talks to the Contributor informally, for example, at scientific meetings,
- has a clear understanding of what part of the results of the contract, if any, should be integrated into the KB,
- receives raw data (as a data set or research product) from a Contributor, verifies and validates it,
- if appropriate, works with the Contributor to create metadata for eventual use in the KB,
- takes research products from Contributors and creates an IRP with its associated IRP document,
- maintains current summary information about the contract on the GNEMRE Coordination web page (https://www.nemre.nnsa.doe.gov/cgi-bin/prod/coord/index.cgi),
- ensures that the contract's results are properly integrated into the KB,
- provides notification of upcoming product integration meetings to GNEMRE management and follows up with documentation of the results of those meetings, and
- is a member of a KB WG.

Product Integrators are scientists at Science Integrator laboratories. Product Integrators interface with Contributors, other members of the KB WGs and IRP Editors.

5.2.10. Science Integrator

The NNSA and DOE laboratories engaged in GNEMRE (LLNL, LANL, SNL, and PNNL) on the KB are Science Integrators. Product integration is performed at the Science Integrator laboratories to package the results of individual Contributors from inside and outside NNSA, and develop individual science contributions as appropriate to fill gaps and enhance other efforts. The Science Integrator laboratories provide important institutional infrastructure and domain expertise that facilitate product development and integration.

6. Classification Guide Interpretation

Classification guides relevant to the U.S. ground-based nuclear explosion monitoring program were interpreted by several experts, resulting in the following working-level diagram. The diagram addresses the integration of unclassified information with information from national technical means of verification.

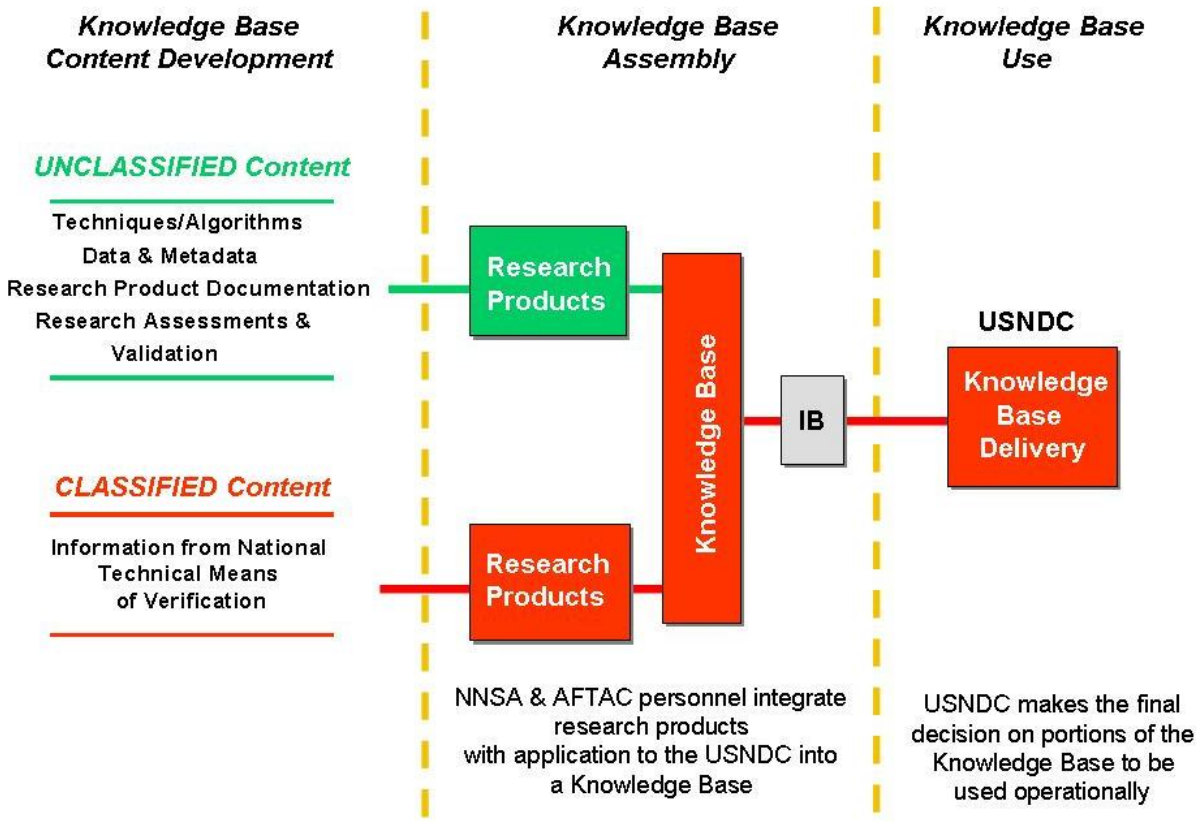

Figure 4—Classification Guide interpretation

As discussed in Section 4, new/updated IRPs are proposed to the KB IB for approval. Each product (classified or unclassified) is tracked independently before a product is integrated into the AFTAC KB. By using a unique tracking number instead of a descriptive product name, we are able to do the tracking on the restricted-access, unclassified GNEMRE website, providing easy internet access to members of the WGs and the KB IB. While every product becomes classified once it has been integrated into the KB, the products delivered to the KB Integration Team for integration may come as unclassified or classified. At AFTAC, all IRPs are immediately moved to the classified LAN. Thus, from November 2007 onward, all KB assembly work, both pre- and post-integration, is done on a classified system.

7. Summary

This report outlines a process to facilitate the formation of reliable and useable updates to the KB in use at AFTAC. Both validation and verification are performed to ensure that the new/updated IRPs delivered to AFTAC are useable, accurate, relevant, and reliable. A protocol is established to assure that all parts of the process are completed. This process forms a shell within which verification and validation are performed.

The intent of this document is to define a common process for the participants in KB development. It is also intended to allow flexibility to suit changing needs. The KB IB has the responsibility to continue to refine the process through practical application and insightful suggestions in order to meet integration objectives and to more efficiently perform our work. These objectives include providing ordered, consistent, easily accessed, well documented, and relevant KB development through verification, validation and management of research products which are collected into IRPs.

8. References

Carr, D. (2003), National Nuclear Security Administration Knowledge Base Contributor's Guide, Sandia National Laboratories, Report No. SAND2002-2771, Albuquerque, NM. (also available from https://www.nemre.nnsa.doe.gov/cgi-bin/prod/nemre/index.cgi?Page=Knowledge+Base)

Carr, D. (2007), National Nuclear Security Administration Knowledge Base Product Integrator's Guide, Sandia National Laboratories, Report No. SAND2004-0809P, Albuquerque, NM. (also available from https://www.nemre.nnsa.doe.gov/cgi-bin/prod/nemre/index.cgi?Page=Knowledge+Base)

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Appendix

Memorandum of Understanding (MOU) amongst Air Force Technical Applications Center (AFTAC) and United States Geological Survey (USGS) and National Nuclear Security Agency (NNSA), signed July/August 2005.

MEMORANDUM OF UNDERSTANDING
AMONGST
AIR FORCE TECHNICAL APPLICATIONS CENTER (AFTAC)
AND THE
UNITED STATES GEOLOGICAL SURVEY (USGS)
AND THE
NATIONAL NUCLEAR SECURITY ADMINISTRATION (NNSA)
REGARDING NUCLEAR EXPLOSION MONITORING
AND RELATED MATTERS

1. Purpose: This Memorandum of Understanding (MOU) formalizes the functions and responsibilities of the Air Force Technical Applications Center (AFTAC), the United States Geological Survey (USGS) and the National Nuclear Security Administration (NNSA), herein sometimes collectively referred to as "Parties" in regard to support for nuclear explosion monitoring and the operation of the U.S. National Data Center (US NDC). This understanding is founded on long-standing, cooperative, working relationships amongst these Parties.

2. Authority: This MOU supersedes the version of 9 May 2001, and complements the following documents that address other aspects of nuclear explosion monitoring:

a. U.S. Nuclear Detonation System (USNDS)–U.S. Air Force (USAF)/DOE MOU, dated January 8, 1997
b. Concerning Cooperation on Matters Pertaining to the Comprehensive Nuclear- Test-Ban Treaty (CTBT)-Department of Defense (DoD)/USGS MOU, dated September 16, 1997
c. DoDI 4000.19, Interservice and Intragovernmental Support, August 9, 1995
d. AFI 25-201, Support Agreement Procedures, May 1, 1996

3. General:

a. Background.

The United States Air Force has long held missions to monitor arms control treaty compliance. AFTAC is responsible for operating and maintaining the United States Atomic Energy Detection System (USAEDS), which provides monitoring for the Limited Test Ban Treaty (LTBT) and the Threshold Test Ban Treaty (TTBT). In an effort to curtail the proliferation of nuclear weapons, AFTAC has undertaken an aggressive program to enhance the capabilities of USAEDS. AFTAC will utilize the full resources of the USAEDS to meet the requirements of the U.S. national policy community for nuclear explosion monitoring and in support of the purpose of this MOU.

The USGS is responsible under the Stafford Act (P.L. 93-288) for reporting earthquakes through the National Earthquake Hazards Reduction Program and for the Global Seismograph Network Program for the monitoring of national and worldwide seismicity and reporting to state, national and international emergency response agencies, and to other interests including the media and the general public. To the extent possible and within its primary responsibilities, the USGS is prepared to employ its national and worldwide seismic monitoring activities to cooperate with other national interests involved in nuclear explosion monitoring, and to apply its other capabilities in related efforts in support of the purpose of this MOU.

The NNSA, through its nuclear weapons laboratories and other Department of Energy laboratories, has broad capabilities and in-depth technical expertise in nuclear phenomenology, nuclear monitoring technologies, and systems engineering and integration. The NNSA's Nuclear Explosion Monitoring Research and Engineering program has a proven record of delivery of integrated state-of-the-art engineered systems to Air Force users for nuclear explosion monitoring. These capabilities are offered to support the purpose of this MOU.

b. Points of Contact

AFTAC/US NDC

Dr. David R. Russell, Director for Nuclear Treaty Monitoring, Air Force Technical Applications Center/TT, 1030 S. Highway AlA, Patrick AFB FL 32925-3002, phone 321-494-2356, fax 321-494-2274, dave@aftac.gov, http://www.tt.aftac.gov.

USGS

Dr. David Applegate, Senior Science Advisor for Earthquake and Geologic Hazards, U.S Geological Survey M/S 905, 12201 Sunrise Valley Dr., Reston VA 20192, phone 703-648-6714, fax 703-648-6717, email applegate@usgs.gov, http://earthquake.usgs.gov.

NNSA

Ms. Leslie A. Casey, Manager of Ground-Based Systems, Nuclear Explosion Monitoring Research and Engineering Program, National Nuclear Security Administration /NA-22, 1000 Independence Avenue, SW, Washington, DC 20585, phone 202-586-2151, fax 202-586-0485, leslie.casey@nnsa.doe.gov , https://www.nemre.nnsa.doe.gov .

4. Responsibilities: This MOU expresses the intention of the Parties to apply their unique resources to a shared goal of improved national security through global monitoring and to collaborate to maximize the effectiveness of existing budgets. The following lists outline the main functions of each organization supporting national security goals related to nuclear explosion monitoring, as well as the development and operation of the US NDC.

a. AFTAC will:

(1) Implement monitoring of current nuclear test limitation treaties (e.g., LTBT, TTBT), moratoria, and agreements.
(2) Support the development and execution of U.S. Government policy with respect to nuclear testing treaties, moratoria and agreements.
(3) Operate and maintain the USAEDS to meet U.S. national requirements.
(4) Operate and maintain the US NDC headquartered at Patrick AFB, in Florida, and the Alternate National Data Center at Goodfellow AFB, in Texas.
(5) Coordinate with USGS in the operation of the Extended National Data Center at USGS' National Earthquake Information Center (NEIC) in Golden, Colorado.
(6) Provide all International Monitoring System (IMS) data and AFTAC non-sensitive unclassified data of interest to USGS to support its mission. Release of AFTAC non-sensitive unclassified data, except IMS Data, requires approval of host country.

(7) Cooperate with USGS and NNSA in the advancement of techniques to improve seismic monitoring and notification, including support to the US NDC.
(8) Provide test beds for evaluating research products and facilitating their transition to the operational USAEDS and US NDC.

b. USGS will:
(1) Host and operate the Extended National Data Center at the USGS' NEIC in Golden, Colorado.
(2) Provide communications connectivity between the US NDC and NEIC.
(3) Adhere to policy provisions provided by AFTAC for distribution of IMS and AFTAC data to other government and research organizations, relying on AFTAC and the CTBT Organization's International Data Center for archival and distribution of USAEDS and IMS data, respectively.
(4) Provide IMS data of interest to the National Oceanic and Atmospheric Administration's Pacific and West Coast & Alaska Tsunami Warning Centers, with external support, and as appropriate given (b.3) above.
(5) Provide to interested parties information collected within its normal mission, on seismic events occurring within the U.S. and worldwide.
(6) Continue reporting on seismic events not related to earthquake hazards, such as mining explosions, with external support.
(7) Cooperate with AFTAC and NNSA in the advancement of techniques to improve seismic monitoring and notification, including support to the US NDC.
(8) Contribute geological expertise and appropriate products to the development of the NNSA knowledge base, with external support.
(9) Provide research, data and analysis products supporting nuclear explosion monitoring, with external support.

c. NNSA will:
(1) Maintain a comprehensive research, development and engineering program (i.e., the Nuclear Explosion Monitoring Research and Engineering Program) to continuously improve U.S. monitoring capabilities to meet U.S. national requirements.
(2) Deliver focused, applied research and engineering products, including an integrated knowledge base, to AFTAC, with appropriate testing, demonstration and technical support, for the US NDC and USAEDS operational systems.
(3) Integrate validated research products into the operational test beds at AFTAC.
(4) Provide the USGS information about seismic events at NNSA facilities, in advance when possible and particularly for those at the Nevada Test Site, to aid nuclear treaty verification and compliance and to assist USGS in providing accurate and timely information to its customers.
(5) Cooperate with AFTAC and USGS in the advancement of techniques to improve seismic monitoring and notification, including support to the US NDC.

5. Funding

This MOU is not a basis for the commitment, obligation or transfer of funds. Specific funding and tasking will be implemented through separate agreements or other documents.

6. Agreement and Administration

This MOU shall become effective upon the latest date of signature of the Parties, and shall remain effective for an initial period of 5 years unless modified or extended before then by written agreement of the Parties. This MOU will be reviewed every 5 years to determine if updating is desired. The Parties may jointly terminate this MOU at any time by mutual agreement or any Party may unilaterally terminate its participation in this MOU upon 6-months' written notice to the other parties.

Approved:

Dr. David R. Russell Director, Nuclear Treaty Monitoring Air Force Technical Applications Center	Dr. Linda Gundersen Acting Assoc. Director for Geology United States Geological Survey	Dr. T. Jan Cerveny Assistant Deputy Administrator Nonproliferation Research & Engineering, National Nuclear Security Administration
(date) 25 JULY 2005	(date) 16 August 2005	(date) 8 Aug 2005

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